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ABSTRACT

Botswana has nearly attained universal primary school attendance, but the additional quantitative intake has weakened the original qualitative base. Employing data collected by the National Commission on Education in Botswana, this study looked for ways to derive benchmark measures of the effects of school quality on learning. One method uses a "school dummy" technique wherein students are ranked according to their exposure to effective schools and a statistical test is employed to see whether this exposure differs significantly between students of modern sector wage earners and farmers. The paper goes on to address the question: When students background and exposure to school quality vary, do learning outcomes vary as well? Findings revealed unique school effects to be 2-3 times more potent than family characteristics for math and reading achievement, with formal teacher training and school library resources good predictors of school quality. When a statistical test was run to determine if test score differences between low socioeconomic status (SES) students attending low and high quality schools were greater than test scores differences between high SES students educated in low and high quality schools, no socioeconomic group was subject to increasing variation in achievement. (Author/BW)

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Quality Schooling in the Kalahari

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Summary

Botwana, like other Sub-Saharan countries stands educationally at a crossroads. The nation has nearly attained universal primary school attendance, but the additional quantitative intake has weakened the original qualitative base. Employing data collected by the National Commission of Education in Gabarone, using IEA instruments, this study looks for ways to derive benchmark measures of school quality on learning. One method uses a "school dummy" technique wherein students are ranked according to their exposure to effective schools and a statistical test is employed to see whether this exposure differs significantly between students of modern sector wage earners and farmers. The paper goes on to address the question when student background and exposure to school quality vary, do learning outcomes vary as well?

Findings reveal:

(1) unique school effects to be two and three times more potent than family characteristics for math and reading achievement respectively with formal teacher training and school library resources good predictors of school quality.

(2) when a statistical test is run to determine if test score differences between low SES students attending low and high quality schools are greater than test score differences between high SES students educated in low and high quality schools; no socioeconomic group is subject to increasing elasticities of achievement.

In Botswana, exposure to higher school quality implies an equality of school effects working to improve math and reading scores equally for everyone, although those improvements do not diminish the existing achievement gap between socio-economically advantaged and disadvantaged students.

Introduction

In rich and poor countries alike, the search goes on for ways to relate school resources to achievement outcomes of school leavers. An assumption often made says that highly trained staff, more textbooks, complete classroom facilities, etc result in better learning environments. Abundant resources lead to more efficient learning in the form of literacy and numeracy outcomes which in turn increase further educational opportunities for those fortunate enough to pursue secondary school. At the same time, better schools prepare primary school leavers to take advantage of wider out-of-school choices at or away from home. While no amount of schooling can create opportunity per se for graduates, additional schooling will increase the possibility of taking advantage of wider and wider arrays of already existing socioeconomic opportunities. 1/ In short, effective schools are successful to the extent they reduce the dependence of a child's opportunity on his social origins, while increasing his dependency on marketable skills.

In LDC's this connection between school quality and learning is especially powerful because the range between schools with few and many resources varies more widely than in developed nations where a higher overall level but smaller range in inputs lowers the likelihood of additional resources greatly altering achievement outcomes. In the former case, government intervention to upgrade inputs stands to boost learning significantly, thereby keeping more children in school longer (Swanson et. al 1981) while offering them quality learning experiences while there. By uniformly raising the inputs of all schools, one can begin to emulate those special learning environments found in a country that yield a superior education due initially to higher school quality. Ultimately, a

better educated student body ensures more widespread educational opportunities and helps to diminish those special advantages that accrue to a superior education afforded at present to only a few. Since diminishing returns to school quality set in above some uncertain level (e.g., diseconomies), better schools begin sooner to yield less while students in initially poor environments can gain disproportionately more from improvements in school quality (all else equal).

Then too, this correlation between better schools and improved learning has consequences for national development because higher academic achievement provides a double pay off for those young citizens who perform well. First, there is evidence that test performance is important in selection to continue schooling. Quantity of schooling attained consistently correlates with higher earnings and this fuels national development. Second, as one progresses up the educational ladder, more and more skills, knowledge, reasoning ability, etc are cultivated. These in turn are useful for filling scarce manpower requirements at intermediate and advanced occupational levels.

But even for those who do not continue beyond primary school, investments in successful academic performance help those who remain in rural areas make the most of local opportunities while simultaneously preventing those future migrants leaving rual areas from entering the urban workforce at the bottoom of the educational skill ladder. For all these reasons, improved primary school quality aids development; better schools further equality of opportunity thereby helping to break the bond between social inequality and life chances.

Finally, there is yet another economic issue which concerns how equitably school quality gets distributed across a population. For political reasons school quality cannot easily be targeted to individual

students or specific groups. Clearly, the present way in which current amounts of school resources are alloted across the board to schools and communities is not likely to change much. The reason it is difficult to target compensatory education to minority groups and the chronically poor is because societies of relative scarcity for the many are hardpressed to redistribute scarce public goods disproportionately to the neediest. Unfortunately, unequal treatment in favor of the poor is politically untenable in most societies. 2/ Fortunately, it appears that those school resources which are utilized by students in producing achievement outcomes are fairly evenly distributed within rich and poor societies already (Heyneman and Loxley 1983).

Given the current status quo in which school enrollments have begun to stabilize and where government planners can begin to reallocate resources more evenly, one wonders which students in particular derive the greatest benefit from the present distributional pattern of school quality. Since the rural and urban poor traditionally perform worse on tests of achievement it would be interesting to note whether school inputs can more readily be substituted for socioeconomic status in the production of achievement performance for these groups. Here substitution implies that a change in achievement performance with respect to school quality depends on a student's particular level of socioeconomic status with greater additional school resources more likely to boost achievement scores for children of the poor.

In conclusion, a substitution effect which shows that the socially least well off systematically gain the most in academic performance from access to similar amounts of school quality would go far to demonstrate that increasing school quality equally improves overall learning efficiency and equity 3/. We propose to test this hypothetical relationship between home, school and learning in Botswana.

Economic Opportunities in Botswana

With a population of around one million and the land area the size of France, Botswana has a US$900 (1979) GNP per capita base to draw from. Public revenues from mining (copper, diamonds, nickle) and livestock (beef processing and animal by-products) have contributed heavily to the public treasury, permitting a level of government intervention in and expansion of the nation's economy which other wise might not be possible.

In Botswana, it is estimated that twenty percent of the labor force is in the formal wage employment sector, eight percent in mining (many work in RSA), five percent in the informal sector and the remaining 66 percent in subsistence agriculture. In fact, well over two thirds of the population rely heavily on agricultural pursuits - farming and cattle raising - while living in small towns and villages scattered in and about the Kalahari Desert.

Although both public and private sector jobs policies have contributed to a steady increase in formal employment (especially construction and utilities industries), along with helping to alleviate severe shortages in practiacally all middle level positons and above, Botswana still faces (1) unemployment problems among unskilled workers due to returning miners from RSA, (2) a rapid increase in new entrants into the labor market, (3) declining agricultural productivity in a sector where three fourths of all people still earn a livelihood. (USAID 1981, World Bank 1981).

With 35 percent adult literacy Botswana needs to continually upgrade the skills of its educated to meet middle level technical and managerial occupational requirements. Simultaneously the nation needs to elevate the education base of the vast majority of the remaining population who do not continue to secondary education so they can take better advantage of economic opportunities both in rural areas and towns during the 1980's.

Educational Opportunities in Botswana

The decade of the 1970's saw a shift from 65 to 93 percent in primary school enrollments. This increase was due to a government policy committed to universal primary education, improvement of educational access for rural farm families, cutting costly dropout and repetition rates, a desire to lengthen the primary school cycle, a need to broaden the nation's educational base and eliminate school fees. These Equity goals have been quite successful although improvement is still sought. Unfortunately, one negative aspect of rapid quantitative expansion has been a diminution in school quality characterized by the lack of trained teachers, shortages of textbooks, classroom facilities, etc.

This inability to provide the best education possible to all students enrolled regardless of social or geographic origins, constitutes an inefficiency of great magnitude. It means, to the extent children are not learning at their potential, students spending seven years in primary school are neither maximizing their government's nor their own investment in acquiring literacy skills relative to staying home on the farm. Staying home certainly implies learning skills of sorts althought literacy and numeracy outcomes are not the ones most likely to be developed. Because nonfarm pursuits in rural areas originate in the search of rural households for earning opportunities that can be combined with farming, exposure to rational thinking skills injected into such an economic situation is thought to stimulate innovation and the rural economy. 4/

For those who continue on beyond standard seven, quality primary school training increases the chances of doing well in secondary school,

and allows greater flexibility in adapting to diverse curriculum programs in math, and the physical and social sciences.

In summary, employment opportunities among skilled and unskilled workers are shifting rapidly in the 1980's. Young entrants into the working age population must somehow be given general skills sufficient to be of help in self reliant activities for either skilled and unskilled jobs in towns or on farms. In a society with only 35 percent literacy, schools become the major institution for transmitting these literacy skills within and between generations. To be judged successful, these schools must teach equally well all children regardless of social and geographic origin.

We now turn to measuring just how effective primary schools are in teaching literacy skills and how equitably these skills get distributed in Botswana. Our first question asks which school resources return the greatest efficiencies to learning, but first we describe our data source.

Data Source

Individual level data on Standard Seven schoolers were collected in 1976 by the National Commission on Education in Botswana. (Husen 1977, Kahn 1978, Kahn and Kelebotsile 1980, Leimu 1976, Smith 1977). Attempts were made to obtain national coverage from six regions of Botswana (see Map) covering 37 schools and 869 students. Similar to IEA school and teacher surveys, a myriad of information was collected: assessments of teacher characteristics, school resources and management policies, student family characteristics. In addition, IEA test instruments in math and reading were administered to students. These tests were intended to tap not just working knowledge of math and reading, but also ability to understand concepts in order to employ them in related problem solving activities.

Given all the available information on schools, teachers and students, a simple statistical methodology was sought which could adequately capture and estimate the effects of schools on learning for Standard Seven students; after first partialling out the influence of nonschool characteristics possessed by students such as age, sex and family social standing.

An Ordinary Least Squares regression model was employed to test (a) particular school inputs which were effective predictors of math and reading school performance (b) the proportion of student academic performance attributable to schools as opposed to family background.

Following these first steps a method was sought to construct a single aggregate measure of school quality, relate it to social background, and then contrast learning outcomes of students from high and low social backgrounds who were exposed to high and low levels of school quality.

Measuring Social Class in Botswana

Differences in social well-being measure levels and access to power and resources in a society. In industrial nations, for example, education, occupation and income are often used to indicate family well-being. Other assets such as a large bank balance, a Mercedes-Benz, in addition to values and attitudes toward the economy, also correlate with family social position but are more difficult to obtain in surveys. In LDC's access to the modern sector wage economy and hence earnings potential is certainly an important indicator of family well-being. Education in this context often plays a substantial role in determining occupational success and ultimately in securing a steady pay check even if it is not a fat salary by local standards. About 40 percent of the Batswanan Student Sample had fathers employed in non-farm occupations, while forty-seven percent had fathers with four years or more of formal education. These parental education and occupational distributions in our sample demonstrate quite nicely the link between employment and the modern wage sector. Seventy percent of children in the sample who had fathers engaged in farm-related work lived in communities under 10,000 population while seventy percent of children in the sample whose fathers were not farmers (e.g., clerical, skilled professional and managerial) resided in villages and town in excess of 10,000 inhabitants.

Given both rural and urban life styles in Botswana, other measures of family well-being were collected by survey including ownership of livestock, time father spends away from home due to working in mines or on cattle ranches, cattle tending at home by children after school, mother's working status, and books in home. The latter measure proxies preference for reading. Inspection of the sample of primary Standard Seven schoolers reveals the following about their home environments:

- 39% of students' fathers were engaged in nonagricultural work
- 40% of all families had more than 20 books in the home
- 46% of mothers did not "supplement" family income by full time work.
- 47% of fathers' had four years of primary education or more
- 55% of all mothers had no schooling at all
- 21% of all fathers did not work away from home more than one month.
- 70% of families spoke English frequently.
- 66% of the students did not tend cattle after school.

In industrialized nation's parental measures of education correlate well with achievement outcomes of childre.. In LDC's this is not often the case and one wonders why parental background factors are not good predictors of achievement. The answer undoubtedly has more do to do with child-rearing practices and the societal reward structure which value positive associations with learning motivation rather than simple lack of variation in the indices themselves. The above measures of Batswanan households are intended to capture more completely the influence of the home on learning.

Estimating The Impact of School Inputs on Learning

Many school quality variables vary considerably across Botswana. Table 1 presents several measures of teacher attributes by region. Regions 1, 3, and 4 are poor areas, the central region is better off and region 6 represents the towns. Teacher quality indicators appear to be distributed in favor of towns and the capital. Average mean differences by region are highly significant and imply that rural areas are disadvantaged relative to the towns. (i.e., a gap of three years in teaching experience for example although it appears that in-service training has helped to right the imbalance). We saw earlier that students whose parents are engaged in nonfarm activities come disproportionately from areas associated with high density populations. Since it is possible that a family's social well-being is associated with better school quality simply by living in urban areas, it is necessary to first account for any achievement variation due to nonschool variables before assessing the impact of individual school inputs. Regression analysis in two steps allows one way to test for this value-added contribution to explaining achievement performance due to individual school and teacher resources (Coleman 1966, Comber and Keeves 1973). 5/

Table 2 presents separate regression results for math and reading scores in which a set of out-of-school characteristics are regressed on student performance scores prior to a set of in school attributes. The information in Table Two can tell us several things about the learning process in Botswana:

(1) Which out-of-school variables are most predictive of achievement among Standard Seven students?

Table 1

Mean Average Levels of Teacher Characteristics by Region

Region	N	Mean Years Teaching 1/	Mean Years Education	Mean Weeks In-Service
Ghanzi-Kgalabadi	43	7.8(1.3)	10.0(1.0)	3.2(1.8)
Central	328	9.4(2.9)	9.6(0.4)	5.7(3.2)
Southern-Kweneng	144	7.6(1.9)	10.0(0.4)	3.3(2.4)
Southeast-Kgatleng	119	7.8(1.3)	10.4(0.5)	1.6(1.0)
Ngamiland/Chobe	126	8.0(1.8)	9.3(0.7)	5.8(3.5)
Towns 2/	109	11.0(1.1)	10.3(1.2)	3.7(2.9)
Total	869	8.8(2.3)	9.8(0.6)	4.4(3.2)

1/ Standard Deviations in parentheses.

2/ Gabarone, Francistown, Lobatse. See accompanying map for geographic locations of the regions.

Table 2

Regression Analysis of Home & School on Math & Reading Achievement.

Predictor Variables	Mathematics Score b	(T-Value) *	Reading Score b	(T-Value)
Out of School Characteristics				
Father White Collar	.343	(3.3)	.256	(3.2)
Father Education	.208	(2.2)	.001	(1.0)
Mother Education	.064	(1.2)	.116	(1.2)
Father Absent from Home	-.022	(1.1)	-.046	(0.8)
Child Cares for Livestock	-.026	(3.2)	-.554	(2.3)
Books in Home	-.262	(0.9)	.071	(1.0)
Frequent use of English in Home	.085	(0.7)	.132	(1.2)
Age of Student	.424	(2.4)	-.453	(4.3)
Mother has Paid job	.320	(1.1)	.304	(1.2)
Male	.424	(2.0)	-.340	(2.4)
In School Characteristics				
No. Times Library Used per Week	1.157	(3.3)	.855	(3.3)
Additions to Library	.653	(4.2)	.837	(6.2)
Ability Tracking	.775	(2.0)	.533	(2.1)
Remedial Math Program	.118	(1.2)	.064	(0.8)
Mean Weeks In-service	-.005	(0.9)	-.059	(1.2)
Class Size	1.136	(3.2)	1.045	(4.3)
Frequent Visit by Educ Officer	.305	(2.0)	-.172	(0.8)
Formal Training of Teachers	1.130	(4.3)	.594	(2.1)
Hours per Week Mark Papers	.047	(2.2)	.035	(2.3)
Frequent use of Class Discussion	-.483	(1.2)	.263	(1.2)
Mean Years Teaching	.503	(2.4)	.811	(3.3)
Frequent use of Tutorials	-.386	(2.0)	-1.08	(1.0)
Adequate Math Texts	.353	(0.8)	-.247	(0.9)
Frequent use of English in Classroom	.297	(0.7)	1.133	(4.2)
Years Experience Headmaster	-.079	(1.2)	-.182	(0.9)
Availability of Taper Recorder	-.644	(0.8)	.194	(1.2)
Math Teachers' Age	.302	(0.9)	.210	(1.0)
Intercept	8.25		13.39	
N	869		869	
F	6.30		10.0	
R^2	.168		.245	

* A t-value of 2.0 is significant at the .05 level.

(2) Which in-school measures are best predictors of achievement once the impact of the previous set of variables has been removed? These latter measures are interpreted as value-added owing to the unique impact of school resources on learning.

The presumption here is that achievement is influenced by sex, age, and home environment but also depends on the level of school resources. The appeal and usefulness of this methodology stems from its consideration of multiple inputs simultaneously so that each variable contributes to the independent contribution of school and teacher resources. This simple technique for assessing school quality comes closer to addressing central policy issues than practically any other available research method, since any significant school input can be contrasted with others in the equation and policy implications drawn based on the given mix of school inputs.

Table Two also suggests that age and sex contribute significantly to both math and reading performance. Here, age is powerfully associated with reading performance in a negative way, while barely significant in predicting math achievement. Since over-aged students (above 16) consitute close to 10% of the sample, the evidence seems to suggest that math learning may be helped by maturation but starting school late hinders reading development. Also over-aged students tend to be boys who often have repeated grades, dropping out and re-enrolling over the years.

By sex, males do better in math and poorer in reading. The father occupation variable which distinguishes farmer's sons from clerical or professional/managerial children is by far the most important measure of the home's influence on learning for, both math and reading, Children who spent time at home caring for livestock do poorer in their school work. All other out-of-school variables have weak impacts on learning. Especially suprising is the finding that frequent use of spoken English

at home along with measures of parental education, have little independent effect on either learning outcome among Standard Seven pupils in an education system where English is the medium of instruction.

Turning to the second set labeled in-school characteristics which were regressed on the two achievement scores following the first set of out-of-school variables, we find an overall pattern which indicates that similar variables have similar effects on each learning score. Looking down the columns we note that any variable with a t-statistic above 2.0 will be sigificant at the .05 level. Library usage is most powerful, as is ability tracking. No surprises here. Class size is a powerful predictor and indicates larger classes promote higher learning in Botswana. Average class size for the sample is 37 (Standard deviation 7.0).[7/]

Formal teacher training and mean years of teaching, two measures of teacher quality, are strong predictors of student academic performance and implies that better educated teachers have been a good investment in Botswana for promoting learning. Likewise, not surprisingly, when frequency of English usage in the classroom is increased, reading performance is affected dramatically while the variable has no impact whatsoever on math performance.

Overall, we find few surprises in the direction school resources have on learning, although in some cases we are amazed to find no impact emerges on a school variable known to predict academic performance at the bivariate level.

Clearly, this analysis shows that a fair set of diverse school elements predict literacy and numeracy skills in Botswana. The magnitude of the t-values denote weights of confidence which can be attached to each school input in the model holding all other variables in control. Under

this criteria, library inputs, formal teacher training, ability tracking and large class size reflect noticably better schools.

Several words of warning about interpreting these measures are in order. First, variable impact on learning is based on a sample of Standard Seven students in 1976 attending school with a given distribution of both student and school/teacher characteristics. This being so, these variables combined in such a way at that time and with those pupils to create a unique meshing of home and school influences; the outcome being that some variables predominated while others did not, even though taken separately all variables initially contributed to learning. Still, for our purposes this ex post analysis does identify the "best" school resource predictors of learning under conditions of relative scaricity nation wide.

We also note the R^2 contributions of the two blocks in the following ways:

1. For math achievement, 17% of all variation could be explained by our measures of home and school. For reading, the figure is about 25%. In both cases a great deal of variation is left unexplained, but this should not deter us because we can be certain that those residuals are not tied to the home and school since we have already extracted the major influence of these institutions. These are two areas of importance we are concerned with in this analysis. In both cases the F-values indicate our regression model to predict a significant amount of variance; certainly no less than what is normally obtained in other school effects research.

2. When we examine the unique impact that schools contribute (value-added) to the portion that we can explain, we find the percentage is formidable: 10% of 17% in Math and 12.5 of 24.5 in reading. These convert to about 60% and 50% respectively of the explicable variance. 8/

While educational planners may find these patterns of school resource effectiveness revealing in their own right, others may simply choose to interpret the impact of schooling more generally by saying that the school's impact is greater than the home and roughly equal for both literacy and numeracy skills. In fact, judging from the possible combinations of all the school variables measured in the data base, we are not likely to predict much more variance in achievement scores by adding still other variables to the model. Our fit is the best we can hope for using simple regression techniques. Knowing we can predict about 20 to 25% of achievement variance we can turn out attention to other ways of ascertaining the impact school quality has on learning.

Another way to measure school effects is to note whether students attending a specific school have a clear advantage over others not attending that school based on the amount of learning that takes place in that educational environment. Outstanding schools, be they the poorest or the best, might offer insight into identifying attributes of these school outliers. We now turn to the method of "School Dummies" using dummy regression to characterize student test performance among the various schools in the Batswanan sample.

Deriving a Single Indicator of School Quality

As we just learned, identifying school resources which proxy school quality can be instructive in deciding which aspects of schools aid learning most powerfully. But we can also calculate the impact that being in one school as opposed to attending another has on learning through the use of dummy variables. This method which has been widely used in "school effectiveness" research (Austin 1981), picks up all between school variation associated with attending school A versus all other schools, School B versus all other schools, etc., for all the schools in the sample. By adjusting for out-of-school characteristics first, the resulting regression coefficient obtained for each school represents a value-added school increment to learning attributed to student performance in a particular school. Measured by a single value for each school, each beta can be ranked according to its size and assigned to every student attending that school. The resulting index which ranks schools by the size of their impact on learning after controlling for antecedent conditions, represents an alternative measure of school effectiveness similar to the end results found in Table Two using individual disaggregated measures of school resources. 9/

Statistically, the overall learning milieu of each primary school in a single measure can be captured in the following two-step procedure. First, through the use of dummy variables, we denote student affiliation in a particular school whereby a one indicates students attend school A and zero denotes otherwise. Dummies are created similarly for each school in the sample, and regressed on student achievement scores after first controlling for the set of social background variables found in Table 2. The product of this first step is a beta coefficient assigned to each

school which shows the impact on achievement performance of a student's placement in one school as opposed to some other school in the sample. The magnitude and sign of beta coefficients derived in this way denotes the position of each school's performance relative to the total achievment mean of all other students in the sample and can be ranked in ascending order form the highest negative to the highest positive value.

To give some examples, we look at school number three in Table 3; the Kanagas school in the Ghanzi region of Botswana, of which 22 Standard Seven pupils were sampled and their reading and math test averages reported as 12.8 and 12.7. When we regress this D_3 dummy variable on reading and math achievement scores we obtain the following unstandardized betas for the two tests: 2.44 for math and 4.06 for reading. Both figures are highly significant and are interpreted to mean that school climate can contribute 2.44 points over the sample's reading score average and 4.06 points above the sample math score average (after partialing out nonschool attributes of students). Since these increases are significantly large and positive, we say school quality is a powerful promoter of learning at Kanagas relative to all other schools in the sample. On the other hand, the thrity-three students at school Number 35 in the Kgatleng region are exposed to a school environment which yields a beta of -0.66 and -1.71 for reading and math respectively. These betas imply that poor school quality exists for these studonts relative to those students attending various other schools in the sample.

Table Three lists the following information for each school in the Botswana sample: starting in column one, school identification number, then number of students surveyed, region school is located, math mean, reading mean, math and reading unstandardized betas and math and reading ordinal rankings.

Finally, ranked by size of impact found in the last two columns, the school quality measures for both math and reading are ready to be correlated with an SES index and tested for the hypothesized substitution effect discussed earlier. 10/

Table 3

Data on Thiry Seven Primary Schools in the Sample

School (1)	Region 1/ (2)	Students (3)	Math Mean (SD) 2/ (4)	Read Mean (SD) (5)	Beta Math (6)	Beta Read (7)	Math Beta Rank (8)	Read Beta Rank (9)
3	1	22	12.8(4)	12.7(5)	4.60	2.44	2.0	3.0
20	1	21	8.1(3)	8.6(3)	-.57	-1.73	21.0	28.3
1	2	18	9.2(5)	9.4(3)	.27	-.56	15.0	21.0
2	2	15	9.5(5)	8.2(2)	-.19	-1.86	19.5	28.5
6	2	21	9.4(5)	9.9(5)	.70	.00	13.0	15.0
7	2	24	9.0(5)	10.7(5)	.55	.95	13.0	8.0
8	2	22	7.6(5)	9.7(4)	-1.33	-.22	30.0	18.0
9	2	17	5.1(3)	6.9(4)	-3.08	-3.04	36.5	37.0
16	2	28	9.0(4)	11.0(4)	.73	7.37	10.0	4.0
17	2	27	10.1(4)	10.0(3)	1.11	-.61	7.5	24.5
18	2	26	8.8(4)	9.5(4)	-1.10	-1.76	27.0	31.5
19	2	25	11.6(5)	9.7(4)	1.70	1.63	5.0	31.5
27	2	28	9.4(5)	13.1(4)	.81	2.94	10.0	2.0
28	2	28	10.8(5)	12.0(3)	.81	.93	10.0	8.0
31	2	20	8.5(3)	11.0(3)	1.02	.00	23.5	15.0
32	2	29	8.8(4)	11.5(4)	.11	1.26	17.0	5.5
5	3	15	11.2(5)	10.3(3)	1.52	.00	7.5	15.0
11	3	18	8.2(4)	10.3(3)	-.25	1.46	19.5	5.5
12	3	21	7.3(3)	9.2(3)	-2.48	-2.15	35.0	34.0
14	3	17	7.5(4)	9.6(3)	-1.50	-.39	30.0	18.0
21	3	29	11.2(5)	10.8(4)	2.23	.43	4.0	10.5
24	3	27	6.4(3)	11.1(3)	-2.97	-.51	36.5	21.0
30	3	23	7.6(4)	9.6(3)	-.81	-.74	23.5	24.5
4	4	20	7.3(4)	8.7(3)	-1.60	-.85	30.0	31.5
10	4	14	11.1(3)	10.4(2)	1.65	-.27	6.0	18.0
13	4	28	9.7(4)	11.0(3)	.00	.35	17.0	12.5
35	4	33	8.8(4)	11.0(3)	-1.71	-.66	32.0	24.5
36	4	24	8.7(4)	8.4(4)	-.73	-2.27	23.5	35.5
22	5	27	8.0(6)	7.7(4)	.00	-.15	17.0	31.5
23	5	24	6.7(3)	9.5(3)	-2.15	-.40	17.0	31.5
26	5	26	7.6(4)	9.3(3)	-1.07	-.99	27.0	27.0
29	5	23	7.3(4)	8.5(3)	-2.26	-2.43	33.5	35.5
33	5	26	7.7(4)	11.0(4)	-1.08	-1.01	27.0	8.0
15	6	26	15.1(4)	20.8(6)	4.80	8.64	1.0	1.0
25	6	24	9.6(5)	9.6(4)	.66	-.67	13.0	24.5
34	6	24	9.4(4)	11.6(5)	-.78	.12	23.5	12.5
37	6	35	12.9(5)	12.3(4)	2.79	.46	3.0	10.5

1/ Regions: (1) Ghanzi-Kgalabadi, (2) Central, (3) Southern-Kweneng, (4) Southeast - Kgatleng, (5) Ngamiland/Chobe (6) Towns: Gabarone, Francistown, Lobatse.

2/ All means are raw scores; standard deviations in parentheses.

The Substitution Effect

Before testing for the interactive effect of home and school, a brief mention of the scoring method used for the SES mesure is necessary. To capture a rough estimate of family importance in Botswana society, nine dichotomous measures of the home were additively combined as follows:

(1) father's education: less than/more than primary school graduate.
(2) mother's education: no schooling versus some schooling.
(3) father's occupation: farmer, other
(4) mother working: yes, no
(5) books in home: less than 20, more than 20.
(6) father absent from home: more than one month a year, one month or less.
(7) English used in the home: rarely or sometime versus often or almost always
(8) Child tends to cattle after school: yes, no
(9) Family owns cattle: yes, no.

A simple summing up was undertaken resulting in a household quality scale, normally distributed with a mean of 13.4 and SD. of 2.1 The maximum score obtained was 17, the minimum 6, with all variables correlating positively with the total. 11/

Similar to regression procedures used earlier, two-way analysis of variance techniques were applied to school quality and social class background of students. In statistical parlance, analysis of variance assesses the linear impact of categorical levels of home and school on learning. Here SES and school quality measures are divided at their median to create low and high categories which can be viewed as treatments: children of farm and non-farm families are enrolled either in low or high quality schools. If membership in different social class categories produce the same effect on achievement whether pupils are exposed to low or high levels of school quality, then the interaction component between the two inputs will tend to be zero and the effects of

home and school can be regarded as additive. However, if a significant interaction between family and school emerges, we would have to conclude that the effect of school quality on learning is not uniform across different categories of social class.

Put another way, we created a four-fold table which allows the researcher to statistically compare means for low and high socio-economic groups exposed to low and high amounts of school quality. We know low SES groups will perform worse than high SES groups. We also know that students exposed to low levels of school quality will perform worse than pupils attending high quality schools. Consequently, corresponding means will increase as one moves from low to high levels of socioeconomic status and school quality. Since we already anticipated these pattern outcomes, more importantly, we would like to see whether those increases are linear or not. If they are not linear, then the resulting interaction between social class and school quality will show either (1) exposure to school quality benefits the low SES groups more than advantaged groups (e.g., a negative interaction) or (2) school quality already benefits socially advantaged groups (positive interaction).

Table 4 reports the findings when such an analysis is performed on both math and reading scores. As expected, we see both SES and school quality significantly affect achievement outcomes independent of one another. Of greater interest, however, we note the sign and magnitude of the interaction term which is not significant for math and only marginally significant for reading. The significance in the latter situation favors the higher SES groups in high quality schools, but is probably due to one school located in the capital performing well above all other schools in the sample. In short, additional school quality boosts achievement performance for rich and poor students in much the same proportion and

implies constant elasticities of achievement performance for both low and high SES groups.

Figures One and Two graphically portray the non-interaction relationship between the home and school and math and reading tests in Botswana. Roughly parallel lines denote no interaction. The lines for reading diverge slightly and reflect a mild interaction in favor of the top group.

Table 4

Effects of Home, School and Interaction Terms on Math and Reading Performance

Subject	Factors	Df	Mean Square	Significance
Math				
	School Quality	1	800	.0001
	Home Quality	1	1386	.0001
	Interaction	1	18	.32
	Explained	3	729	.0001
	Residual	865	18	
	Total	868	20	
Reading				
	School Quality	1	789	.0001
	Home Quality	1	1348	.0001
	Interaction	1	89	.05
	Explained	3	742	.0001
	Residual	865	15	
	Total	869	17	

Conclusions

Faced with burgeoning primary school enrollments and limited resources, Botswana must somehow figure out ways to invest in quality school inputs that can be distributed as equitably as possible across both geographic and divergent economic segments of the nation's population if all children are to effectively master what is taught in schools.

A reanalysis of individual level IEA data collected in 1976 on a national sample of Standard Seven students in Botswana, provided some benchmark measures of:

(1) specific school inputs to math and reading achievement,

(2) the relative merits of unique school and household contributions to academic performance using traditional variance explained procedures,

(3) the nonadditive impact of home and school effects on learning by employing tests of interaction between the two sets of resources.

These results show that:

(1) library facilities and formal teacher training are presently good investment strategies for boosting basic literacy and numeracy skills in primary schools.

(2) the unique contribution of the school exceeds that of the family by factors of two and three for math and reading respectively.

(3) neither the socially advantaged nor disadvantaged presently gain disproportionately on academic tests from exposure to increased levels of school quality.

While further work is required to chart the distributional and utilization patterns of primary school resources across other groups of students (e.g., males, females, urban, rural, low, high ability), initial findings show little pattern differences in the manner scholastic benefits are awarded to attending rich and poor schools based on family background.

FOOTNOTES

1/ Investments in primary schooling help to overcome many of the characteristics of those entering the labor force that act as impediments to greater productivity and earnings including poor health, unreceptiveness to new knowledge and ideas and ways of doing things, fear of change, lack of incentive and risk. A central aim of educating is to allow human beings, wherever born, to be able to develop to the fullest extent of their capacities, both in order to fulfill themselves and in order to contribute to the common heritage of civilization. (Streeten, 1976:108). However, where education lifts the spirit but no alternative opportunity exists, education can fail to promote change.

2/ The fact that each child begins life with a disparate set of private resources implies that in the absence of public expenditures, children will have quite unequal opportunities. Since it is not possible with publicly provided money to provide every child with the same opportunities afforded the child with the greatest private resources, it is more practical to decide what level and imbalance of public resources should be invested to reduce the level of inequality that arises from private resources.

3/ Interesting results found in the U.S. (Rizzuto 1977) showed that the poor derived greater benefits from additional fundings for schooling. This is similar to what was found by Heyns (1978) when she looked at who gained the most learning from summer school; namely, the poor. Loxley (1983) found the socially disadvantaged in Egypt to gain in achievement disproportionately from better school resources. Papancolaou and Psacharopoulos (1979) found social background and schooling (years) to interact in England in producing earnings in favor of lower social background.

4/ Allowing for some absorption into farming and for the expansion of non-agricultural employment, a developing economy needs to have at least 50% of its children in primary schools (Lewis, 1966:109).

5/ Because students in schools differ at the outset, it is not possible merely to judge the quality of the school by the achievement of students leaving it. It is necessary to control in some way for the variations in student inputs with which the teachers and staff of the school are confronted. Hence, we use the student's own background which can provide an estimate of the student's input to the school.

6/ These estimated regression coefficients in multiple regression are interpreted as partial slopes. They try to answer the question: When school quality indicators change by one unit, and all the other variables are held constant in a statistical sense, how much change is expected in achievement performance. The answer is revealed in the size of the beta coefficient.

7/ Larger classes may simply be picking up economies of scale controlling for other school variables in the equation. In general, no distinctive pattern differentials in class size emerged across geographic regions.

8/ Under the present method of obtaining achievement variance due to home and school, the household indicators not only receive credit for their unique impact on achievement, but also any common variance explaining achievement due to jointly home and school. This latter amount results from correlation between home and school inputs and should be removed from the family effect column if a true picture of net impacts of home and school are to be contrasted. (see Madaus et al. 1979 for the proper accounting procedure). When this is done, taking math first, we find that SES accounts for 18%, school inputs for 41% and shared explicable variance assigned to both home and school to be 41%. For reading, the percentages are 18%, 49% and 33% respectively. Thus, when shared variance due to both home and school are isolated from the unique home effect, we find the school effect to be two and three times as great as the home on math and reading achievement respectively.

Source	Math	Reading
Unique Family Effects	18%	18%
Unique School Effects	41%	49%
Common Variance	41%	33%

9/ The dummy method employs the following equation:

$$Y = A + [B_a X_a + B_b X_b + \ldots B_z X_z] + [B_A + B_B X_B + \ldots B_Z X_Z]$$

where bracketed lower case subscripts denote social background and other controls and the upper case bracketed subscripts denote the array of dummy variables corresponding to individual schools in the sample. In general, this dummy method constrains the slopes to the parallel and it looks only at average means of schools. It is possible that variance distributions within schools themselves are egalitarian (i.e., all children perform at much the same level) or elitist (i.e., all children in a school perform unequally).

10/ The regression of school inputs from Table 2 on our school quality ranking obtained from the school dummy method yields an R^2 of .49. School variables from Table Two which show up as big predictors include: additions to school library, weeks in-service, hours per week marking papers, mean years teaching, frequent use of English in classroom. Close association between our school dummy method and individual school input measures shows similarity in predicting quality schools regardless of whether particular school input items are used or whether an overall measure is obtained from a dummy regression procedure. This consistency of result helps to confirm the validity of our school quality measure.

11/ These nine dichotomous measures of pupil socioeconomic status composed a scale with a mean of 13.4 and a standard deviation of 2.1. Each individual item positively correlated with the total score and together contributed to a reliability coefficient of .51 engendering confidence that the scale proxies what it purports to measure. Item to Scale correlations are: father occupation .34, father education .30, mother education .31, books in home .26, English used in home .14, mother does not work .16, child does not tend cattle .18, father not absent from home .07, family owns cattle .03.

The following is a list of schools in the sample and accompanying percentages of farmers' children attending. Sample mean is 60 percent.

School ID	Percent	School ID	Percent	School ID	Percent
1	83	13	32	25	58
2	67	14	94	26	62
3	59	15	5	27	82
4	95	16	93	28	43
5	60	17	67	29	48
6	81	18	15	30	83
7	92	19	40	31	75
8	68	20	62	32	48
9	82	21	79	33	73
10	21	22	88	34	25
11	98	23	79	35	42
12	57	24	76	36	46

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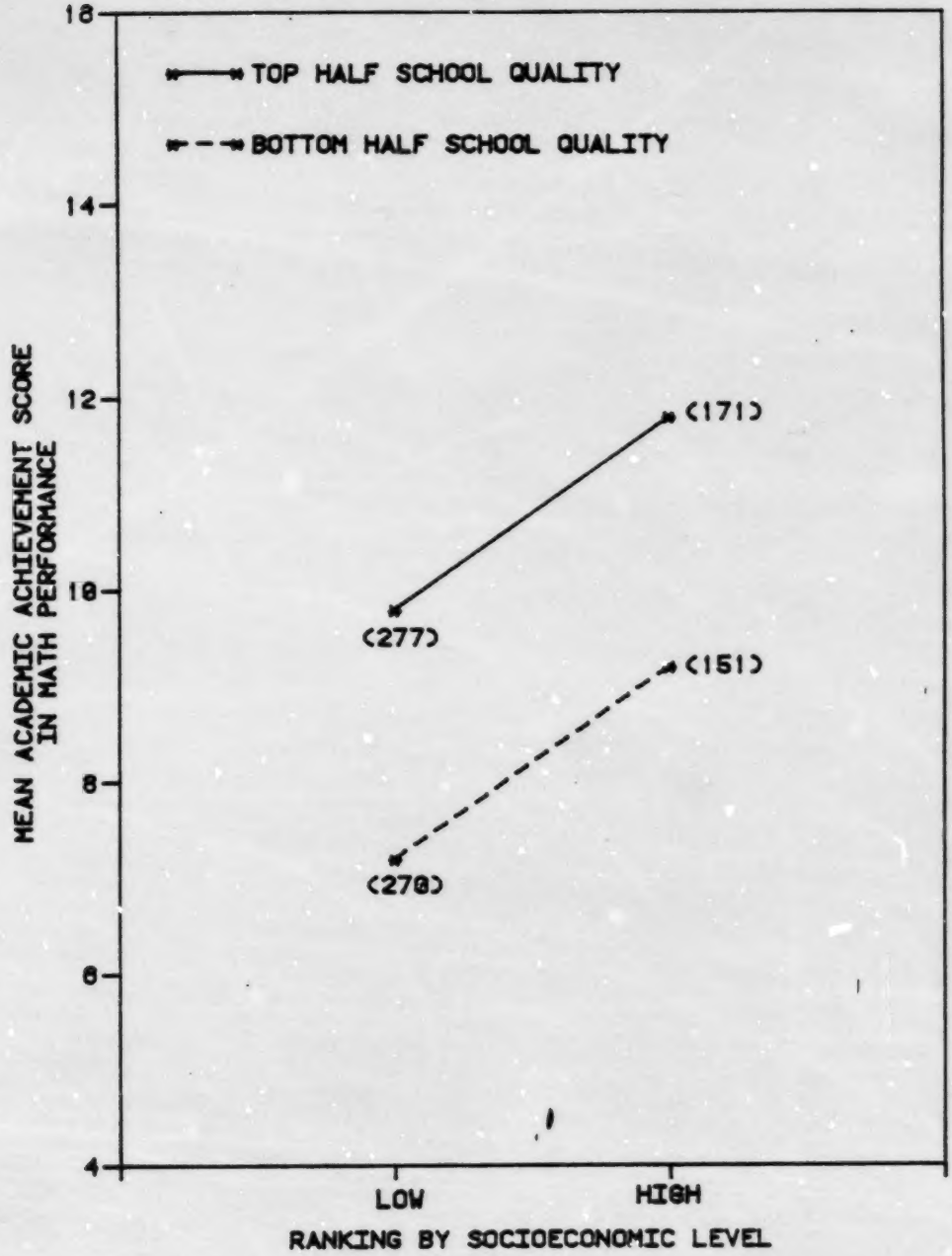
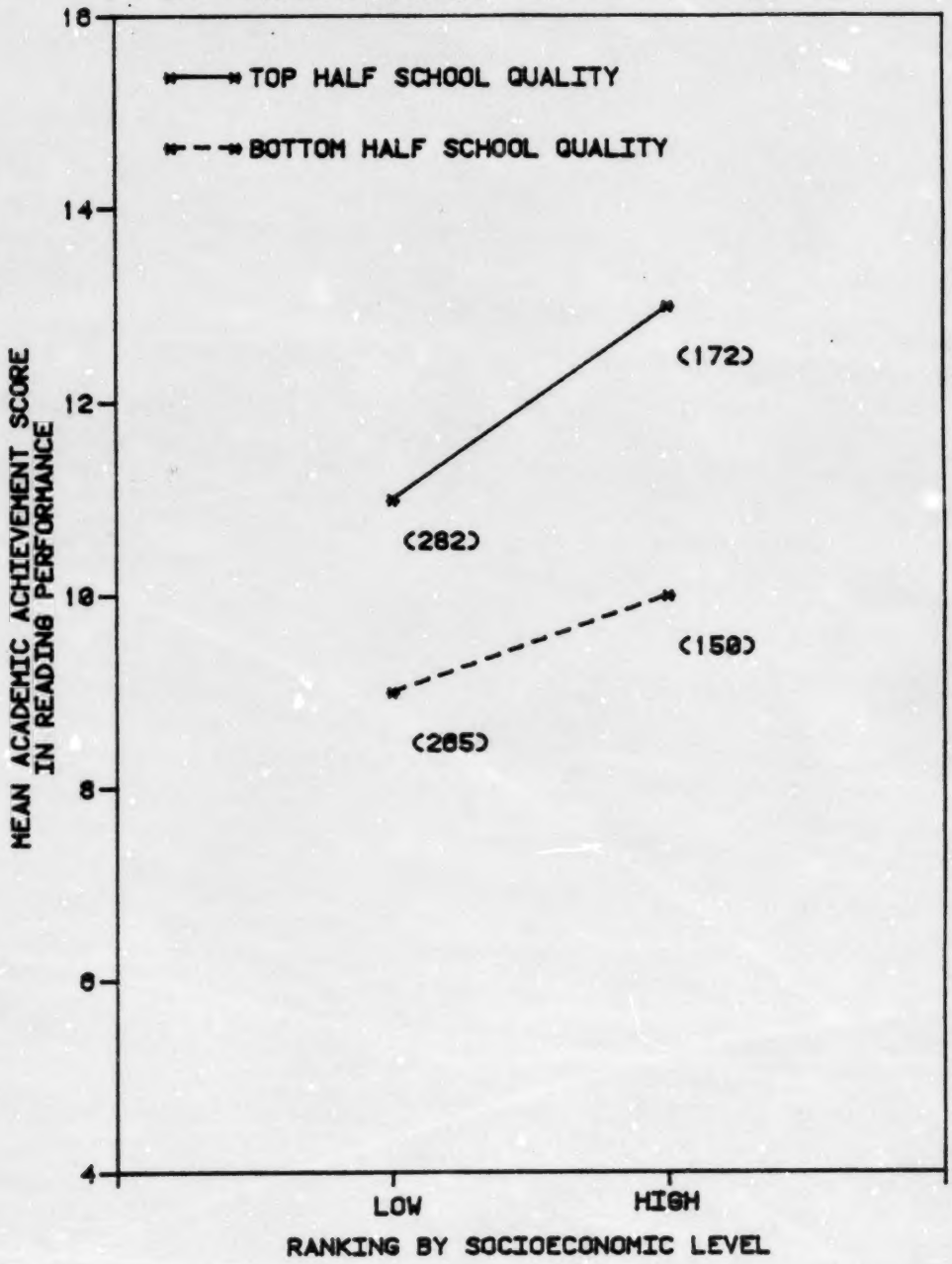
FIGURE 1
MEAN MATHEMATICS ACHIEVEMENT PERFORMANCE
FOR PRIMARY SCHOOL LEAVERS IN BOTSWANA

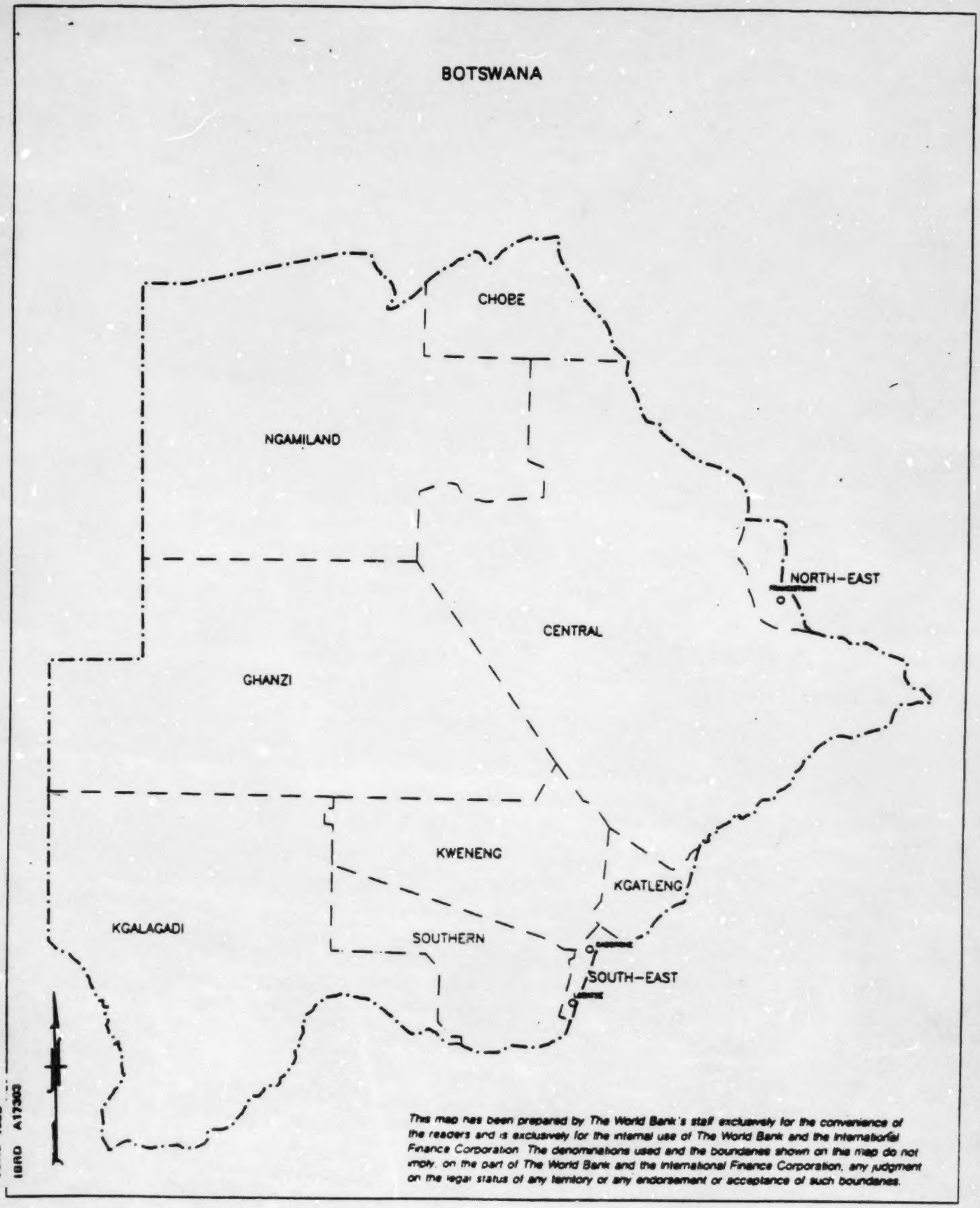


NOTE: NUMBER OF STUDENTS IN PARENTHESES.

FIGURE 2
MEAN READING ACHIEVEMENT PERFORMANCE
FOR PRIMARY SCHOOL LEAVERS IN BOTSWANA



NOTE: NUMBER OF STUDENTS IN PARENTHESES.


BOTSWANA
CHOBE
NGAMILAND
NORTH-EAST
CENTRAL
GHANZI
KWENENG
KGATLENG
KGALAGADI
SOUTHERN
SOUTH-EAST
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